WHAT IS CLAIMED:

[0034] 1. An apparatus for processing a workpiece comprising:

a liquid supply source;

one or more liquid outlets disposed to apply liquid onto the workpiece;

a liquid flow line extending between the liquid supply source and the one or more liquid outlets for carrying liquid to the liquid outlets;

at least one heater for heating the liquid before it is applied onto the workpiece;

an ozone gas supply system which provides ozone gas around the workpiece; and

a sonic energy source for introducing sonic energy to the workpiece.

[0035] 2. The apparatus of claim 1 further comprising a sonic energy conductor in contact with the sonic energy source and in contact with the sonic energy source.

[0036] 3. The apparatus of claim 2 wherein the sonic energy conductor comprises quartz, silicon, metal or a polymer.

[0037] 4. The apparatus of claim 1 with the sonic energy source associated with the liquid outlets, to provide sonic energy to the workpiece via liquid moving out of the outlets and onto the workpiece.

Karp

ľLi

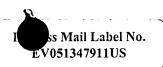
15





- [0038] 5. The apparatus of claim 1 wherein the sonic energy source comprises a sonic transducer including a focusing chamber for concentrating sonic energy onto the workpiece.
- [0039] 6. The apparatus of claim 1 where the liquid supply source comprises a liquid reservoir, and where the heater heats the liquid in the reservoir.
 - [0040] 7. The apparatus of claim 1 where the liquid supply source includes a liquid selected from the group consisting of, ammonium hydroxide, sulfuric acid, hydrochloric acid, hydrofluoric acid, a surfactant, de-ionized water, and a combination thereof.
 - [0041] 8. The apparatus of claim 1 further comprising a chamber around the workpiece and with the ozone gas supply connected to the chamber to provide ozone gas around the workpiece in the chamber, with the ozone provided as a dry gas or in a liquid.
 - [0042] 9. The apparatus of claim 8 further comprising a re-circulation liquid line extending between the chamber and the liquid supply source.
- [0043] 10. The apparatus of claim 8 further comprising a rotor assembly in the chamber for rotating the workpiece.
 - [0044] 11. The apparatus of claim 1 where the liquid outlets comprise liquid nozzles for spraying the heated liquid onto the workpiece.





[0045] 12. The apparatus of claim 1 further including means for controlling the thickness of a layer of the liquid formed on the surface of the workpiece.

[0046] 13. The apparatus of claim 12 where the means for controlling comprises a liquid flow control system for controlling the flow of liquid onto the workpiece.

5 [0047] 14. The apparatus of claim 13 where the liquid flow control system includes spray nozzles.

[0048] 15. The apparatus of claim 12 where the means for controlling comprises a rotor for holding and rotating the workpiece.

[0049] 16. An apparatus for treating the surface of a workpiece comprising:

a liquid reservoir for holding a process liquid;

a process chamber;

and the second of the second

liquid spray nozzles within the process chamber disposed to spray liquid onto the workpiece held by the workpiece holder;

a workpiece holder within the process chamber;

a liquid flow line extending between the liquid reservoir and the liquid spray nozzles;

an ozone generator for generating a supply of ozone;

one or more ozone supply lines extending from the ozone generator to the process chamber;

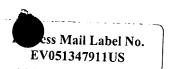
at least one heater for heating the process liquid; and

20

15

15





a sonic energy source on the workpiece holder for introducing sonic energy to the workpiece.

- [0050] 17. The system of claim 16 where the workpiece support holds the workpiece in a horizontal orientation.
- The system of claim 16 further comprising a valve connecting to a spent liquid line extending from the process chamber, to the liquid reservoir, and to a drain, with the valve switchable between a first position, wherein spent liquid from the process chamber is directed back to the reservoir, and a second position, wherein spent liquid from the process chamber is directed to the drain.
 - [0052] 19. A method for processing a workpiece, comprising the steps of:

 positioning the workpiece at least partially within a bath of liquid;

 creating an ozone atmosphere above the surface of the bath of liquid;

 applying sonic energy to the bath of liquid;

moving at least one of the workpiece and the surface of the bath of liquid, to cause the surface of the liquid to move across the workpiece surface.

- [0053] 20. The method of claim 19 wherein the workpiece is positioned within the bath of liquid by lowering the workpiece into the bath.
- [0054] 21. The method of claim 19 wherein the workpiece is positioned within the bath by raising the surface of the liquid.





- [0055] 22. The method of claim 19 with the workpiece fully submerged in the liquid, while sonic energy is applied.
- [0056] 23. The method of claim 19 further comprising heating the liquid to a temperature above ambient.
- 5 [0057] 24. The method of claim 19 further comprising positioning the workpiece in a second bath, removing the workpiece from the second bath, and drying the workpiece.
 - [0058] 25. The method of claim 19 where the liquid comprises water.
 - [0059] 26. The method of claim 25 with the liquid further comprising a member selected from the group consisting of HF, HCl, NH₄(OH), NH₄F.
 - [0060] 27. The method of claim 19 where the ozone atmosphere is created above the surface of the liquid by injecting ozone gas above the surface of the liquid.
 - [0061] 28. The method of claim 19 where the ozone atmosphere is created above the liquid surface by bubbling ozone through the liquid.